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ABSTRACT

The objective of this study was to determine if the Annehurst Curriculum Classification System (ACCS) learner characteristics and curriculum materials classifications among elementary mathematics students, can be used as the dimensions of an aptitude-treatment interaction analysis. The subjects were 34 fourth and fifth graders in three open-space individualized mathematics classrooms. The pupils and their materials were classified high or low by ACCS criteria on the ten categories: experience, intelligence, motivation, emotion-personality, creative, social and verbal expression, visual perception, auditory perception, and motor perception. Achievement scores on summative exams, attitude scores as measured by a semantic differential, and number facility aptitude scores were collected. Using a general linear regression technique, the ATI's were tested. When only ACCS variables were the dimension of the ATI analysis, no significant interactions were found. When number facility was used as the aptitude and material classification the treatment, there were significant disordinal interactions for the ACCS categories of experience and emotion-personality. (Author/GA)

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Annehurst Curriculum Classification System Variables as Dimensions of Aptitude Treatment Interactions

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The study reported here was part of a national consortium of curriculum researchers in schools and universities. The broad goal is to investigate the Annehurst Curriculum Classification System (ACCS) as a meaningful tool in aiding the individualized education process. ACCS is an outgrowth of Frymier's (1973) book: A School for Tommorrow.

The main objective of this study was to determine if the ACCS pupil characteristics and curriculum materials classifications among elementary mathematics students can be used as the dimensions of an aptitude-treatment interaction analysis. Other analyses included: measuring the aptitude of number facility, calculating interactions using the ACCS curriculum material classification as the treatment variable, and comparing the total ACCS interactions (i.e., those using only ACCS variables) to partial ACCS (i.e., those using an ACCS variable and a DAT type variable). A secondary objective of this study was to determine the extent to which teachers select curriculum materials which are appropriate for learners as measured by the ACCS system.

Background:

Recently the Annehurst Curriculum Classification System has surfaced as an educational research tool (Davis, 1977). ACCS provides investigators with a framework for classifying both learner and curriculum materials on interactive dimensions. The exact nature of ACCS as well as its developmental history have been delineated by Frymier (1977b). "ACCS has been developed to help teachers make the best possible match between learners and curriculem materials... within a schooling paradigm, the basic purpose of ACCS is to help teachers create a match between a particular learner and particular curriculum materials that will enable the student to learn effectively and enjoyably." (p 3). Consequently, ACCS provides researchers with a vehicle for evaluating the interaction between learners and the curriculum they encounter.

Paper presented at the annual meeting of the American Educational Research Association, Toronto, March 30, 1978.

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The Annehurst Curriculum Classification System grew out of the conviction that pupil achievement is influenced by the appropriateness of specific curriculum materials given the pupils needs and characteristics (Frymier, 1973). Thus, there theoretically exists an aptitude-treatment interaction between learner characteristics and curriculum materials characteristics. This study was a limited investigation of the extent to which the theoretical interaction effect between type of curriculum material used and specific learner traits is quantifiable. Student achievement and attitude were the criteria in ATI analyses. The techniques for the analyses were those suggested by Cronbach and Snow (1977).

Each piece of curriculum material as well as each pupil may be classified on ten human characteristics: experiential, intellectual, motivational, emotion-personality, creative, social, visual perception, auditory perception, verbal expression, and motor perception. The usability and reliability of these classification procedures have been established in earlier studies (e.g., Davis, 1977; Frymier, 1977a). Davis showed that ACCS can be used in a research study in situations in which the teachers have not been trained in the use of ACCS and the curriculum materials have not been previously classified. The same techniques have been adopted for this study.

A brief explanation of what is meant by an aptitude-treatment interaction is in order. The reader is referred to Cronbach and Snow (1977) for a more detailed and more complete explanation. The following draws on pp 18-22 of that work. In many educational studies, the researcher includes aptitudes only as a control variable. The criterion difference between treatments is assumed to be constant (see figure 1). If the investigator reports only that the mean outcome is higher in treatment A than in treatment B. The report then suggests that treatment A is better for everyone. Figure 1 is typical of the results of what some researchers call analysis of covariance.

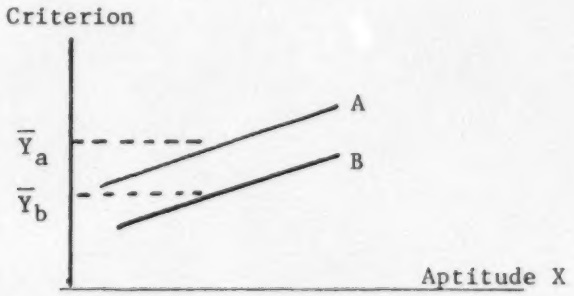

Figure 1

Parallel Regression Lines
No Interaction

In figure 2, an ATI is depicted. The AT regression for treatment B is steeper than that for A. Individuals with high aptitude generally do better if assigned to treatment B. Treatment A tends to be superior for persons with low aptitude scores.

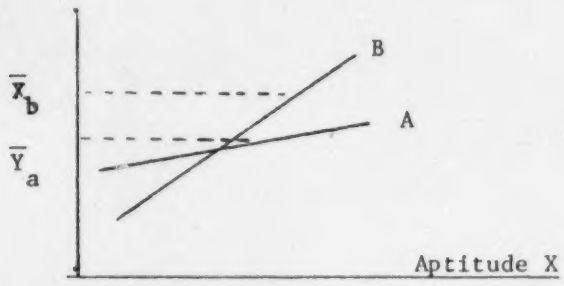

Figure 2

Non Parallel Treatment
Regression: ATI present

Procedures

Subjects:

The subjects in this study were twenty-one fourth graders in three classroom in three different schools, and thirteen fifth graders in one school. There was a total of thirty-four subjects, seventeen of which were girls. The classrooms used were selected by the building principal and the subjects were chosen at random by the investigators. Some effort was made to select students from the different geographical areas of the rooms.

Data Collection:

Three trained observers[1] watched the subjects as they worked on mathematics lessons for a three week period of time. An observer, using a special coding sheet, recorded the material's name, length of time of use, type of instructional strategies, and level of classroom structure. The observers later coded each piece of material according to the ACCS criteria.

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[1]Recognition is due trained observers Lisa Monahan Smith and Melody Guadagnoli for their capable and tireless assistance with this study.

Prior to the actual observations, the observers were trained in the use of the ACCS system. The two principal investigators had been trained in the use of ACCS at earlier sessions with Dr. Frymier. After training, inter-observer reliability was established by having each observer independently rate three quite different pieces of material. The ratings were compared on each category and a percent of agreement found. The percent of agreement, .92, was considered satisfactory as an estimate of reliability.

The mathematics classrooms[2] in which the observations were conducted were all flexible space situations in which the students had some freedom of movement, some choice as to what he could be doing, and a variety of curriculum materials from which to select. During mathematics class, the students were normally under the direction of a single teacher. Each teacher was working toward individualizing instruction to some degree.

After each observation period, the investigators conferenced with the teachers and classified each student on the ten ACCS variables using the criteria set out by Frymier (1977a). Further data were gathered on attitude and achievement.

The attitude instrument was a slight modification of McCallon and Brown's (1971) semantic differential. The reliability and validity of the instrument had been established by the authors and was well suited for the present study. The modifications were to substitute easier to understand synonyms for certain of the bi-polar adjectives; e.g., safe-dangerous was substituted for secure-insecure. Two of McCallon's scales were left off because the adjectives could possibly not be understood by the subjects. The instruments were scored by substituting numbers for the subject's check marks. The mean of the evaluative scales (Osgood et al, 1957) ratings was a subject's attitude score.

The achievement scores were derived scores based on: (1) standard normal scores for teacher made achievement tests and (2) a desired distribution with a mean of 100 and a standard deviation of 10. The results of the teachers' summative examination composed the raw achievement data. The tests were given at the end of the unit during which the observations were made.

Arithmetic aptitude scores were the raw scores on the N-1 and N-3 tests measuring the cognitive factor of Number Facility (Ekstrom et al,1976). The number right on each test were added together. The sum was the aptitude score. For ATI purposes, subjects scoring below the mean were considered low on the aptitude and subjects scoring above the mean were considered high.

Data Analysis:

The ATI's were tested for using a general regression technique(e.g.,

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[2]The authors thank the teachers and students at the University of Wyoming Lab School, Laramie, Wyoming and at Davis and Woodlake Elementary Schools, Carrolton, Tx. for their help and cooperation.

Cronbach and Snow, 1977; Ward and Jennings, 1973; Holton, 1975). Forty seperate regression analyses were ran; twenty for achievement and twenty for attitude. In analysis of variance terms, the study represented a two by two factorial design (see figure 3) with either achievement or attitude as the variable of interest.

		Low curriculum material	high curriculum material
learner ACCS classification	low		
	high		

Figure 3

2 x 2 Factorial Design

The analysis was performed for each of the ten scales of ACCS categories. The full and restricted models (Ward and Jennings, 1973) were:

$$Y = b_o + b_1T + b_2X + b_3(T \times H) \qquad \text{Eq. 1}$$

$$Y = b_o + b_1T + b_2X \qquad \text{Eq. 2}$$

where

T = 1 if observation made on high curriculum material
= 0 if observation made on low curriculum material

X = 1 if observation made on high aptitude
= 0 if observation made on low aptitude

T x X is the cross product of predictors T and X and represents the interaction term.

Equation 1 is the starting or full model which includes the interaction term. If the restricted model, equation 2, is equivalent to equation 1 (i.e., there is no significant difference in the r^2 values for equations 1 and 2) then there is said to be no interaction. The equations would be equivalent if the null hypothesis of $b_3=0$ is not rejected. However, if the r^2 value changes significantly, the interaction is significant. One can further

expect that if the interaction is significant, that b_3 would be significant.

Finally, the Number Facility aptitude was substituted into the place of ACCS learner characteristics. The results of these analyses have been termed partial ACCS interactions and were subjectively compared to the full ACCS interaction analyses results. A secondary analysis compared the appropriateness of material selection to the inappropriateness of material selection using chi-square procedures.

Results:

There were no significant interactions using the ACCS dimensions as the variables in a two by two design. Table 1 shows the solutions to the regression analyses using achievement as the criterion variable, the full model solutions are shown in the left part of the table. The column labled $t(b_3)$ is the test statistic for the hypotheses $b_3=0$. None of the t values were significant. The solution to the restricted model is shown on the right hand part of the table. The regression weights b_0, b_1, and b_2 in the restricted model are similar to the corresponding weights in the full model. The F statistic is the basis for the decision rule in comparing the full and restricted models (Jennings, 1973, pp 289-295). I. e., the $F = ((ESS_r - ESS_f)/(p-q))/(ESS_f/(n-p)))$ where p and q are the number of independent variables in the full and restricted models respectively. Table 2 displays the same information as table 1 for the criterion of attitude.

The prediction equations are essentially the same for each of the ten ACCS categories. For every equation, the coefficient of determination is relatively small. Consequently, one might conclude that ACCS variables are relatively poor predictors of academic success and student attitude toward mathematics.

Table 3 displays the means and standard deviations of the two dependent variables. The sample size is only thirty-four. This is a limitation of the study. Cronbach and Snow (1977, pp 55-57) point out that when N per treatment is less than 100, the power is significantly reduced and the risk of a type II error increases. Thus, when this study is repeated, the researcher should have a sample size greater than 100 per treatment and take steps to include more students who are classified low on the experience, intellectual, and motivation categories. The extremely low F values, however, are an indication that the likelihood of a type II error is not as high as one would get using Cronbach and Snow's criteria.

When the aptitude of number facility is substituted for ACCS learner classification in the analyses, some significant interactions appear. Tables 4 and 5 are constructed isomorphically to tables 1 and 2 using achievement and attitude as the dependent variables. When attitude is used as the criterion, there are significant disordinal interactions on the ACCS categories experience and emotion-personality against Number Facility. (See figures 4 and 5). There is also a significant interaction for visual

perception (see figure 6).

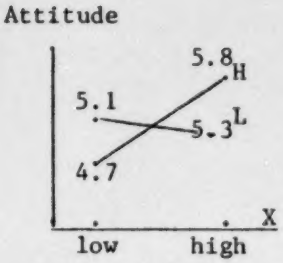

Fig. 4
Exper x Number

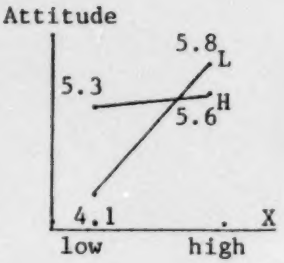

Fig. 5
Emotion x Number

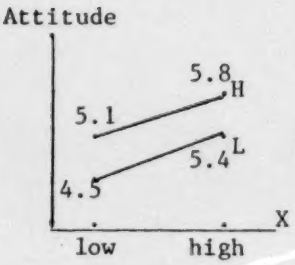

Fig. 6
Visual x Number

Note that for each of these interactions, the t statistic (see Table 4) for each of the b_3's is significant as expected.

An examination of the coefficients of determination and the F values in Table 4 provides subjective evidence that the apptitude of number facility is a better predictor of student attitude toward mathematics than the ACCS learner classification. Further study with other apptitude measures would be interesting.

A secondary analysis showed that for the two ACCS categories of experience and intellectual, the frequency of appropriate learner to material match ups was significantly less than the frequency of inappropriate match ups (see Table 6). Furthermore, the frequency of appropriate match ups on the motivation category was significantly greater than the frequency of inappropriate matchups. One could hypothesize that since the curriculum materials are, on a regular basis, not appropriate for the learner as defined by ACCS, the low r^2 values in Tables 1,2,4, and 5 are in part due to this poor record of match ups. In future studies, existing interactions might be discovered if the frequency of appropriate and inappropriate match ups were balanced, i.e., in analysis of variance terms there should be equal cell Ns.

Summary and Discussion:

The ten ACCS categories of experience, intelligence, motivation, emotion-personality, creative, social, verbal expression, auditory perception, visual perception, and motor perception were used as the dimensions of aptitude-treatment interaction analyses. The two dependent variables of achievement and attitude resulted in twenty regression analyses. The interactions were tested using a generalized regression technique. No significant ATIs were found. Further comparisons were made by substituting the aptitude of number facility for learner characteristics and twenty more analyses ran. There existed significant disordinal interactions for

number facility x experience (materials classification) and number facility x emotion-personality when attitude was the criterion.

Experience and intelligence, as defined by ACCS, played an important role. More frequently than not, the materials were inappropriate for the learners which influenced the balance of the experimental design.

Although the rationale for the interaction between learner characteristics and material classification is quite reasonable, the interactions are difficult to quantify.

Further studies should be made which attend to the points: (1) a larger sample size needs to be used to increase the statistical power and reduce the likelihood of a type II error, (2) the study should take place over a longer period of time, (3) the teachers should be trained in the use of ACCS to insure a larger frequency of appropriate learner-material match ups, nad (4) more materials which are rated high on the ACCS categories of experience, intelligence, and motivation should be introduced into the instructional setting.

As a closing point, the authors recommend caution in using statistical procedures as the sole basis for curriculum decisions. Cronbach and Snow (1977) have produced the best reference source for ATI research. While they are clearly proponents of the ATI hypothesis, they also favor an "open eyes" approach

> Instruction decisions must be based on a whole complex of student characteristics and teacher actions. There is no such thing as a homogenous group of students or a specifiable "method" of instruction. Educational practice... will have to make its adaptations informally and judiciously, not by an actuarial technology of cutting scores and regression equations. (p vii)

Table 1

Summary of Interaction Effects
Learner Characteristics x Curriculum Material Classification
Dependent Variable = Achievement

ACCS Category	Full Model						Restricted Model				
	b_o	b_1	b_2	b_3	$t'(b_3)$	r^2	b_o	b_1	b_2	r^2	F
Experience	100.1	3.20	-3.9	9.35	.007	.183	99.9	3.20	8.9	.190	.030
Intellectual	99.1	1.51	3.7	1.04	.370	.062	99.5	1.87	3.6	.058	.138
Motivation	100.4	3.81	-.21	-2.36	-.80	.096	101.1	2.65	-1.04	.076	.66
Emotion-Personality	104.6	1.79	-6.5	-2.36	-.81	.022	104.6	.73	-.77	.178	.068
Creative	101.1	1.90	-5.1	-3.1	-.72	.018	101.0	1.90	-5.7	.017	.009
Social	102.9	-.98	-5.3	3.48	.64	.033	102.6	-.46	-3.1	.02	.418
Verbal Expression	100.9	4.2	-5.7	-1.3	-.42	.180	101.1	4.02	-5.7	.120	.450
Auditory Perception	100.1	1.83	-6.1	-2.1	-.93	.030	102.1	.92	-.81	.21	.083
Visual Perception	100.9	4.37	-1.61	-3.44	-.79	.109	104.8	-.96	-4.4	.063	1.59
Motor Perception	99.5	4.35	-2.5	-1.38	-.35	.176	99.7	4.07	-2.24	.017	3.25

Table 2

Summary of Interaction Effects
Learner Characteristics x Curriculum Material Classification
Dependent Variable = Attitude

ACCS Category	Full Model						Restricted Model				
	b_o	b_1	b_2	b_3	$t(b_3)$	r^2	b_o	b_1	b_2	r^2	F
Experience	5.26	.045	.343	.001	.002	.022	5.24	.045	.66	.018	.146
Intellectual	5.42	.201	-.39	.10	.31	.098	5.40	.24	-.41	.095	.10
Motivation	4.85	.68	.47	-.60	-1.7	.185	5.0	.40	.22	.106	1.08
Emotion-Personality	5.12	.159	.30	.02	.01	.043	5.12	.16	.30	.043	.007
Creative	5.1	.17	.27	.01	.001	.010	5.1	.16	.30	.010	.004
Social	5.24	-.126	.96	-.27	-.41	.090	5.26	-.17	.78	.085	.165
Verbal Expression	4.99	.49	-.27	.45	.09	.025	5.0	.51	-.31	.024	.070
Auditory Perception	4.87	.75	.49	-.53	-1.8	.190	4.9	.45	.49	.110	.05
Visual Perception	5.06	.58	.10	.46	.88	.009	4.84	.29	.45	.074	.810
Motor Perception	4.95	.61	-.44	-.74	-1.52	.208	5.09	.46	-.30	.148	2.376

TABLE 3

MEANS AND STANDARD DEVIATIONS

OF DEPENDENT VARIABLES

Variable	N	$\overline{X}$	SD	Min.	Max.
Achievement	34	101.74	8.94	75	114
Attitude	34	5.30	1.12	3.2	7.0

Table 4

Summary of Interaction Effects
Number Facility x Curriculum Material Classification
Dependent Variable = Attitude

ACCS Category	Full Model						Restricted MOdel				F
	b_o	b_1	b_2	b_3	$t(b_3)$	r^2	b_o	b_1	b_2	r^2	
Experience	5.26	.27	.69	1.68	2.29*	.262	5.26	.37	.69	.133	5.424*
Intellectual	5.61	.28	-.98	.60	1.74	.307	5.67	.49	-.82	.237	3.158
Motivation	5.33	.64	.04	-.55	-1.49	.173	5.28	.36	.04	.112	2.29
Emotion-Personality	5.08	.72	.42	-.79	-2.25*	.274	5.11	.39	.45	.152	5.208*
Creativity	5.52	.75	.39	.65	1.01	.281	5.53	.79	.40	.279	.71
Social	5.14	.44	.90	-.13	-.27	.216	5.14	.42	.94	.214	.074
Verbal Expression	5.13	.52	-.75	-.62	-.18	.182	5.14	.50	.42	.181	.008
Auditory Perception	5.18	.43	1.30	-.31	-.47	.244	5.18	.41	1.39	.238	.23
Visual Perception	5.12	.83	.38	-.84	-2.46*	.286	5.08	.36	.39	.143	6.26*
Motor Perception	5.41	.36	-.63	.06	.123	.160	5.41	.37	-.63	.159	.015

*$p < .05$

TABLE 5

NUMBER FACILITY X CURRICULUM MATERIAL CLASSIFICATION

DEPENDENT VARIABLE = ACHIEVEMENT

ACCS Category	Full Model						Restricted Model				
	b_o	b_1	b_2	b_3	$t(b_3)$	r^2	b_o	b_1	b_2	r^2	F
Experience	101.09	1.53	10.91	.49	.07	.116	101.09	1.56	10.91	.116	.005
Intellectual	101.2	2.31	2.64	-2.99	-.94	.068	100.9	1.29	1.85	.04	.91
Motivation	102.74	1.84	-1.96	- .21	-.06	.044	102.72	1.73	-1.96	.043	.003
Emotion-Personality	104.76	.42	-7.09	1.74	.59	.198	104.69	1.14	-7.17	.189	.36
Creative	102.7	1.65	-3.92	.52	.09	.120	102.5	1.51	-4.13	.112	.78
Social	102.2	1.2	-2.2	1.3	.30	.046	102.19	1.4	-2.55	.043	.094
Verbal Expression	103.6	1.82	-4.31	-2.81	.41	.05	103.7	1.85	-4.02	.048	.62
Auditory Perception	102.01	1.81	-4.51	-4.31	-.74	.059	102.02	1.46	-3.20	.0418	.570
Visual Perception	104.2	1.95	-4.38	- .46	-.15	.010	104.13	1.69	-4.37	.092	.022
Motor Perception	102.64	.93	-5.14	3.57	.89	.105	102.64	1.56	-5.14	.081	.827

TABLE 6

FREQUENCY OF APPROPRIATE VS INAPPROPRIATE

SELECTION OF MATERIALS

ACCS Category	Frequency of Appropriate	Frequency of Inappropriate	X^2 (df = 1)
Experience	71	223	78.6**
Intelligence	77	217	66.6**
Motivation	194	102	30.0**
Emotion-Personality	134	164	1.15
Creative	141	155	.49
Social	166	130	5.0 *
Verbal	146	150	.01
Aduitory	175	121	10.6 *
Visual	161	135	2.6
Motor	164	132	3.9 *

* $p < .05$

** $p < .01$

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